A design-led approach to transforming wicked problems to design situations and opportunities

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This paper argues that using a design-led approach is highly beneficial when tackling complex problems to transform ambiguity into actionable design briefs and solution opportunities. This is evidenced by way of an ongoing project with a large public-sector organisation. Northumbria University's School of Design academic experts use design-led approaches to innovation that promotes 'creative fusion' between diverse stakeholders in order to tackle 'wicked problems'. The authors continue this work as part of an AHRC/ERDF-funded programme entitled Creative Fuse North East (CFNE), involving five regional universities, of which the project discussed here is a part. The main objectives of CFNE are to develop and deploy approaches to innovation that apply skills from creative graduates to benefit the wider creative economy, address barriers to innovation and promote growth and sustainability within and without the Creative, Digital and IT sector (CDIT). The authors propose that to do this it is vital to convert stakeholders into co-creation activists empowered with the creative confidence and tools required to speculate about uncertain futures.

design catalysts, co-creation, frames, multidisciplinary, creative confidence

1. Introduction

Society faces increasingly ill-defined, networked, dynamic and seemingly intractable problems (Dorst, 2015). Such problems have been termed 'wicked problems' (Rittel & Webber, 1973). Wicked problems require specific working practices to frame and address them since "we are at a critical point where rapid change is forcing us to look not just at new ways of solving problems but to new problems to solve" (Brown & Katz, 2009, p. 153). We cannot achieve this in isolation as individual knowledge can only be partial (Russell, 2010). Rather, collective wisdom from multiple disciplines must be directed towards a common purpose, tackling the wicked problem. Furthermore, methods of inquiry and decision-making need to be flexible so that one can remain open to revisions in response to new information (Russell, 2010). It is not straightforward to work collaboratively within ambiguous and complex spaces such as these. Collaborators and stakeholders can bring conflicting requirements and their personal or institutional perspectives to collaborations (Brown, 2010; Dorst, 2015) and uncertainty can be uncomfortable. Here, a design-led approach can be invaluable (Kyffin, Aftab, Spencer, 2017). Through the use of design, it is accepted that problem and solution understanding co-evolve whilst addressing complex, ill-structured, wicked problems (Dorst and Cross, 2001). This is particularly relevant when the topic under investigation is new and dynamic as in this case study presented.

A design-led approach has been argued to offer a holistic way to tackle wicked problems (Hocking, 2010; Lam, 2017). When applied during 'problem framing' (Dorst, 2015), it can transform seemingly intractable, complex problem spaces into actionable briefs and solution opportunities that bring clarity, meaning and direction. (e.g. Wrigley, 2017; Gulari &

Fremantle, 2015; Innovate UK, 2015; Bucolo & Matthews, 2011) and social innovation (e.g. Nusem, Wrigley & Matthews, 2017; Brown & Wyatt 2010). Often, the special way that designers think and do things is cited (e.g. Dorst, 2011; Beckman & Barry, 2008; Cross, 2006).

This can be captured as a working practice involving flexibility and action. For example, Hocking (2010, p.244) describes designers as considering:

> *questions about what could, should or ought to be [...] through the ability to enact knowledge in an iterative process where the identity of the designer is central and the paths they follow have dynamic variability [...] characterized by playfulness and praxis, bridging knowledge and action.*

These abilities are employed strategically within organisations to enable them to: identify emerging opportunities; investigate and visualize how issues are interconnected; frame focused questions to tackle the core issues; and collaborate with diverse disciplines through design-led methods and tools (Lam, 2017; Price et al., 2013). It could be argued that Hocking's (2010) 'identity of the designer' should be replaced by the 'designerly purpose', identified by Bailey, Aftab, and Duncan (2014), which focuses on the particular values that drive the individual designer's actions. Indeed, we see the emergence of the importance of the common (designerly) purpose of the team (Spencer et al., 2017). This change reflects the importance of co-creation, evidenced in this paper by way of the Creative Fuse North East (CFNE) action research programme's case study project that employs an innovation approach previously termed as 'creative fusion' (Sapsed et al., 2013)

The case study in question addresses the complex, wicked problem of cybercrime vulnerability. In this case study, the team[1] have enabled people to work together in this uncertain and complicated environment in order to reach strategic solution opportunities. This has been achieved through facilitating those who may not feel comfortable with ambiguity to welcome it and encouraging people to bring ideas to life in ways that encourage speculation and 'what if?' questions (Coyne, 2005).

2. Context: A design-led approach to facilitation, co-creation and problem framing with multidisciplinary teams

Multidisciplinarity offers a breadth of knowledge and perspectives that helps produce multiple opportunities and solutions (Alves et al., 2007). A meaningful multidisciplinary collaboration enables teams to be more than the sum of their parts and achieve things they could not have if working individually. Amongst other benefits, multidisciplinary teams can act as 'outsiders' to each other to identify and question assumptions (Nissani, 1997). Through collaboration, previously separate concepts, expertise, products or services may be united in new and unexpected ways to create innovative solutions (Fong, 2003) and "new ways of thinking, communicating and working" (Bailey, Smith, & Aftab, 2013, pp. 12-13). These are not new ideas, but they remain pertinently evidenced in, for example, policy making (see Department for Business, Energy & Industrial Strategy, 2017).

[1] Collectively known as 'the team', Northumbria University's CFNE team consists of design-led innovation academics, researchers and Innovators in Residence (IiR) – recent Masters graduates who support the projects whilst being mentored by the NU as they launch their own businesses.

Hand-in-hand with a multidisciplinary approach, the authors advocate an inclusive process, where stakeholders are actively involved as experts during problem framing and co-creation activities (Broadley et al., 2016; Björgvinsson, Ehn, & Hillgren, 2010). Co-creation is a broad term, but can be defined as two or more people working creatively in collaboration (Sanders & Stappers, 2008). This approach is based on the principle that everyone, with the right facilitation, can be creative (Stappers and Sanders, 2008).

Multidisciplinary co-creation presents challenges, especially when working with 'wicked problems' and this may be heightened when participants come from different backgrounds. Teams need to build trust (Broadley et al., 2016), identify a common purpose (Spencer et al., 2017), and find effective ways to communicate and generate a collective knowledge base (Sanders & Westerlund, 2011). Furthermore, roles must be clarified (Facer & Enright, 2016) and conflicting perspectives managed (Björgvinsson, Ehn, & Hillgren, 2012b). Therefore, collaborations require facilitation as people may not have worked in this manner before and, as Sapsed et al. (2013, p. 68) postulated, "people live and socialize in unfused professional, disciplinary and social communities. When these different cultures are brought together, it often exposes cultural mismatches rather than creative opportunities".

Particularly relevant to this paper are recent proponents of using designers to instigate and facilitate collaborations, for example calls from industry (Design Council, 2015; Bucolo & Wrigley, 2014; Fraser, 2012; Liedtka, 2011; Verganti, 2009) and academia (Wrigley & Straker, 2017; Bowen et al., 2016; Sanders & Stappers, 2008). A design-led approach to co-creation (Davis, Docherty, & Dowling, 2016) includes activities that encourage participants to (amongst other things):

- visualize information to enhance understanding and communication (Schoffelen et al., 2015);
- make physical things to make sense of the problem space and prototype ideas (Sanders & Stappers, 2014; Vaajakallio & Mattelmäki, 2014);
- look at issues from different perspectives, for example through storytelling (Bornet & Brangier, 2016; Nusem, et al. 2013);
- engage with ideas in a meaningful and playful way (Björgvinsson, Ehn, & Hillgren, 2012a; Gray, Brown, & Macanufo, 2010).

A design-led approach can be used to address challenges associated with multidisciplinary co-creation and ensure groups arrive at implementable outcomes (Norman & Verganti, 2014; Bucolo, Wrigley, & Matthews, 2012). Moreover, a design-led approach helps collaborators to accept the inherent ambiguity in the imperfection of wicked problems through activities which frame ambiguity positively as a space for speculation (Dorst, 2015). Being prepared to speculate and build a deeper understanding is a key capability within design and innovation practice (Sanders & Stappers, 2014; Buchanan, 1992). By employing designerly methods, these speculations can be brought to life in physical, visual or narrative forms. Generating multiple potential speculations and solutions both develops the team's understanding of the problem, i.e. 'framing' it, and facilitates refinement of the most promising solutions into viable propositions (Boer & Donovan, 2012; Bucolo, Wrigley, & Matthews, 2012). Problem-framing involves collecting perspectives from stakeholders, systematically visualising and interrogating this information, and then using it to generate more pertinent and strategic questions (Lam, 2017; Buchanan, 1992). One aspect of this is balancing goal-orientated and experimental activities (Lam, 2017). De Mello Freire (2017) frames this as pursuing non-linear thinking (characterized by changing circumstances, multiple parts, and adaptability) in

a manner that is beneficial rather than detrimental to linear thinking. This activity may appear chaotic and undirected (Sanders & Stappers, 2008). Nevertheless, there is an overall trajectory towards more definable and actionable briefs and solution opportunities. It is this trajectory that this paper explores.

In the fields of psychology and behavioural studies, both problem-focused and solution-focused approaches are explored in relation to goal-oriented activities. Bandura (1982) establishes the concept of self-efficacy in pursuit of self-determined goals and Kelley and Kelley (2013) draw an important comparison between self-efficacy and creative confidence. Concluding this paper, we consider the implications of adopting a more optimistic mind-set in problem and solution-framing that builds on this psychological perspective.

The evolving role of design and design-led, or design-infused (Myerson, 2018), innovation is increasingly highlighting a bifurcation of application: Design Execution - using the designers knowledge, technical skills and craft to make manifest tangible products, systems and services and Facilitation by Design - using the designers' 'soft-skills' and curiosity, coupled with carefully crafted, tailored resources to facilitate creative knowledge sharing and generative co-creation within teams of 'non-designers' (Krabye, et al., 2013). Such skills and resources may be termed *enablers*.

3. A conceptual framework

Co-creation at Northumbria University (NU) is grounded in design practice and supported by business knowledge. It uses strategic, creative and generative methods to frame problem and solution spaces that co-evolve with design facilitation to encourage innovation. Like many design innovation models, NU's approach involves several divergent and convergent activities in order to gain understanding, generate knowledge, establish empathy with stakeholders, and build trust and creative confidence in activists with different interests and roles within the project. At points of convergence, new themes and patterns emerge leading to new ideas. These act as value scaffolders for creative briefs and strategies, and as common ground around which diverse stakeholders can converge. As seen in Figure 1, this approach follows an iterative process of X number of activities that vary according to the project needs. This allows a set of core resources/activities to be adopted, adapted and deployed at different points in a project journey.

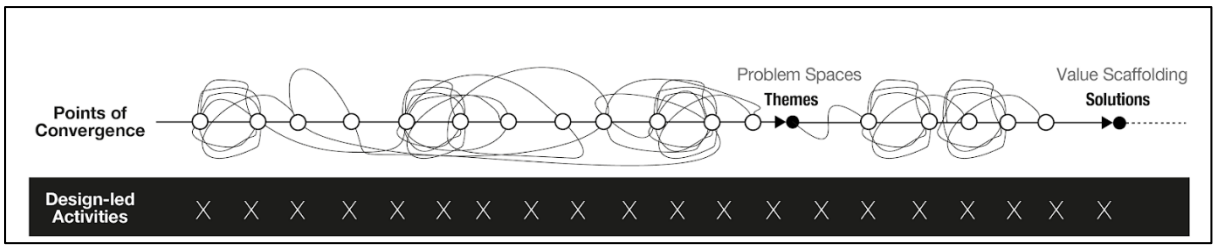


Figure 1: Illustration of the co-evolution and iterative process of the problem and solution framing across a project journey.

The 'designerly' ways in which the team at NU facilitates this way of working can be summed up by 6 'co-creation enablers'. These are presented below and further build on the relevant literature discussed hitherto.

Enabler: Environment

The importance of creating an appropriate and supportive environment for innovation has been covered extensively (e.g. Dombrowski, et al. 2007). Likewise, many design thinking proponents discuss appropriate spaces, both physical and mental, that can enable and facilitate multidisciplinary collaboration (e.g. Brown & Katz, 2009). Often features such as flexible (changing according to project needs), open and dedicated project spaces, equipped with creative resources to enable reflection and visualisation are cited as key components of environments that foster collaboration and innovation (Davis, Docherty, & Dowling 2016). Co-creative environments must ensure that they are inclusive i.e. all voices are equally heard (Fremantle, et al. 2016), and they are not built on hierarchy but on a shared control and ownership manner (Bødker, 1996). At NU, such a 'safe' environment is created which includes both appropriate physical space and resources, and a supportive non-judgemental intellectual and visceral space for open engagement (Bailey & Smith, 2010).

Enabler: Participation

Finding appropriate means for involving stakeholders from different backgrounds, interests, experiences and roles is a key challenge in every co-creation activity (Schoffelen et al., 2015). Whilst establishing a network of stakeholders to contribute diverse knowledge and expertise is needed it is equally important to ensure the right conditions are in place to enable meaningful and active participation (Broadley et al., 2016; Bødker, 1996). This enabler, therefore, is concerned with creating the right conditions for participants to act both as *experts* (i.e. share knowledge and expertise) and as *activists* (i.e. actively involved in co-creation activities) with an enhanced sense of empowerment and ownership during project activities. This needs to be nurtured in each participant in order that they are supported to develop their individual, and thereby the group's, creative confidence: "the ability to come up with new ideas and the courage to try them out" (Kelley & Kelley, 2013, p. 6).

Enabler: Structure

Traditionally, co-creative and participatory design activities are practised through some form of workshop with "predefined staged settings in which people gather for specific design purposes and are supported by a specific structure and design tools" (Schoffelen et al., 2015, p. 180). However, when working on dynamic wicked problems, NU's model advocates an approach that, rather than being a prescriptive toolkit, is also dynamic; confident, deliberately semi-structured and open to change as circumstances change and ideas develop.

Enabler: Attitude

The nature of work within the design discipline is often characterized by a set of 'design attitudes' (Michlewski, 2016 such as embracing ambiguity and complexity, being open and questioning, engaging deep empathy, and bringing things to life through making. When working with non-designers, these attitudes may differ significantly; often, there is lack of mutual understanding of the situation, lack of trust, different worldviews, motivations and so forth (Broadley et al., 2016). NU's approach facilitates a 'designerly' attitude based loosely on Sinek's (2011) 'why, how and what' questions. However, critically, these are accompanied by 'what if?' questioning in order to generate provocative speculations as the genesis of concepts (Bailey et al., 2013).

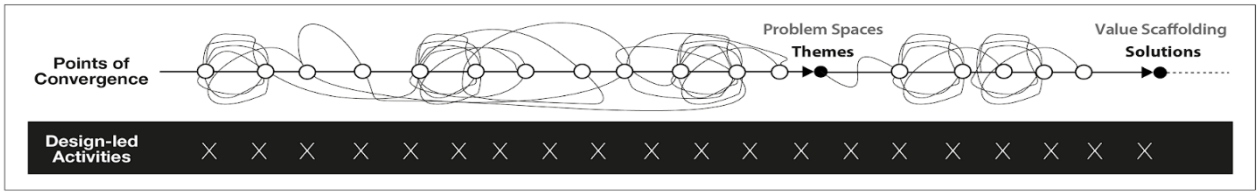
Enabler: Visualisation

An important aspect in co-creation and participatory design practice relates to the adoption of appropriate tools that are used by both designers and non-designers to facilitate reflection, imagination and expression of visions, ideas and concepts (Sanders & Stappers, 2014). Like the open and flexible environment and structure discussed earlier, a range of design-led tools (including mapping, sketching, prototyping, storytelling etc.) are used to translate 'what if?' questions into tangible forms to aid communication, sense-making and reflection (Schoffelen et al., 2015; Björgvinsson et al., 2012b). These co-creation tools are bespoke and tailored to the needs of each particular project activity whilst purposefully designed to foster a playful, exploratory, imaginative, dialogical and empathetic mindset (Vaajakallio & Mattelmäki, 2014).

Enabler: Agents

Within innovation, business and entrepreneurship literature, the presence and role of 'innovation champions' is cited as a key catalyst to business success and innovation (e.g. Rogers, 2003). Such champions have been defined by Jenssen and Jörgensen (2004, p. 65) as "an individual that is willing to take risks by enthusiastically promoting the development and/or implementation of an innovation inside a corporation through a resource acquisition process without regard to the resources currently controlled". More recently, Wrigley (2016, pp. 151-2) introduced the term "Design Innovation Catalyst" to describe the key individuals whose role is to "translate and facilitate observation, insight, meaning, and strategy", engage and involve many different internal and external stakeholders, and iteratively prototype solutions and form value propositions for the organisation. NU's approach celebrates such roles through a combination of experienced design-led academics and multidisciplinary innovation students. The students' role is particularly vital in the approach (Morehen, Wrigley & Wright, 2013). They act as catalytic agents in a problem situation due to their 'creative naivety' (Bailey, Aftab, & Smith, 2015) - they are curious and knowledgeable, and give 'professionals' permission to work creatively and ask 'dumb' questions which often challenge company-held perceptions and preconceptions.

Application of these enablers (Figure 2) will be traced through the case study. This serves to demonstrate some of the highly beneficial ways a design-led approach can help frame wicked problems through facilitating meaningful collaboration and co-creation between people from diverse backgrounds.



NU's 6 Co-Creation Enablers	
Environment	A safe environment is created which includes both appropriate physical space and resources, and a supportive non-judgemental intellectual and visceral space for open engagement (Bailey & Smith, 2010).
Structure	A confident, deliberately semi-structured approach is taken which is open to change as circumstances change and ideas develop.
Participation	Establishing and engaging with a network of stakeholders to contribute diverse knowledge and expertise. Participants include experts (who contribute knowledge) and activists (who are involved in co-creation activities) indeed participants may be both.
Attitude	An open and questioning attitude (Michlewski, 2015) is facilitated based loosely on Sinek's (2011) 'why, how and what' questions. However, critically, these are accompanied by 'what if?' questions in order to generate provocative speculations, the genesis of concepts (Bailey et al., 2013).
Visualisation	A range of tools used to translate 'what if?' questions into tangible forms to aid communication, sense making and reflection (Björgvinsson et al., 2012b; Schoffelen et al., 2015).
Agents	Students are catalytic agents in a problem situation due to their 'creative naivety' (Bailey, Aftab, & Smith, 2015) - they are curious and knowledgeable, and give 'professionals' permission to work creatively and ask naive questions which often challenge company-held perceptions and preconceptions around the problem space.

Figure 2: Northumbria University's conceptual design-led innovation framework.

4. Research Aims

As part of the CFNE action research programme, the team set out to develop and deploy approaches to innovation that apply skills from creative graduates to benefit the wider creative economy, address barriers to innovation and promote growth and sustainability within and beyond the Creative, Digital and IT sector (CDIT). The research aim set out in this article was to test NU's design-led innovation approach as an effective way to convert stakeholders into co-creation activists empowered with the creative confidence and tools required to address wicked problems and speculate about uncertain futures. Therefore, the research questions set out to explore through this case study were;

1. *How do 'co-creation enablers' support stakeholders, unfamiliar with creative and collaborative practices, to acquire the necessary creative confidence needed to become co-creation activists?*

2. *Are design-led methods and approaches an effective way to transform highly complex, 'wicked' problems into a set of actionable design briefs that can increase the potential for meaningful innovation?*

4.1. Research methodology

A case study research methodology (Yin, 2014; Gerring, 2007) over a single case design (Flyvbjerg, 2011) has been used. Case study research is an empirical method of enquiry that seeks to investigate in-depth phenomena situated within real life settings. The paper focuses on a single case study in order to observe and explicate phenomena associated with particular activities taking place within a specific situation and context. The study adopted a

phenomenological approach where both the researchers and participants were part of the context being studied (Flyvbjerg, 2011) and co-creators of meaning (Robson, 2002). According to Flyvbjerg (2011, p. 304), a single case study is an adequate unit of analysis insofar as the case has been strategically chosen. This paper adopts a paradigmatic case choice which is appropriate for representing a given practice and school of thought by highlighting its characteristics and offering a 'practical prototype' as reference points to its function (Flyvbjerg, 2011, p. 307). Moreover, this approach allowed the researchers to achieve a thorough understanding of both context and process as well as linking causes and outcomes to the observable phenomena.

4.2. Methods of data collection

Primary data was collected on the process, methods, tools and approaches utilized and a rich collection of project collateral generated by the team and project participants was reviewed. Analysis of data focused on finding the extent to which the design-led activities, tools and methods were effective means for bringing diverse stakeholders together and empowering them actively to co-create problem and solution frames. This data was supplemented by an action research approach based on the authors' active involvement, facilitation and observations made throughout the duration of the project. This research approach was appropriate to the needs and purpose of this study because it built upon "the natural process of planning, acting and critically reflecting on the results – bridging the gap between practice and theory" (Wrigley, 2017, p. 6).

5. Raising Awareness and Changing Behaviour: From a wicked problem to actionable solution opportunities in Cyber Security

Earlier, we proposed 6 co-creation enablers that support people as they move a wicked problem-space from a position of ambiguity to one where there are strategic and actionable solution opportunities. This is evidenced and explored further here by way of the following case study which analyses a programme of activity undertaken through the aforementioned CFNE programme. The project responded to challenges associated with digital policing practices around cybercrime and cybersecurity. This challenge is a truly dynamic wicked problem; it is large in scale, involves multiple stakeholders and is ill-defined, for example key factors are rapidly changing and difficult to clearly establish.

The project involved 13 key design-led activities, labelled here with a letter (A, B, C etc.). A summary of activities A to M is depicted in the project journey timeline below (Figure 3 & Figure 4). The case study represents three core phases of activity which we detail in the following sections:

- Project Establishment and Initiation which involved the core NU Academics and Researchers along with Partner Institution Academics, Northumbria Police and IiR's (Activities A and B).
- Student-led Project which involved the MDI students, supported by NU Academics and IiRs working with multiple different stakeholder groups (Activities C to L).
- Analysis and Recommendations which involved NU Academics, IiRs and Northumbria Police (Activity M).

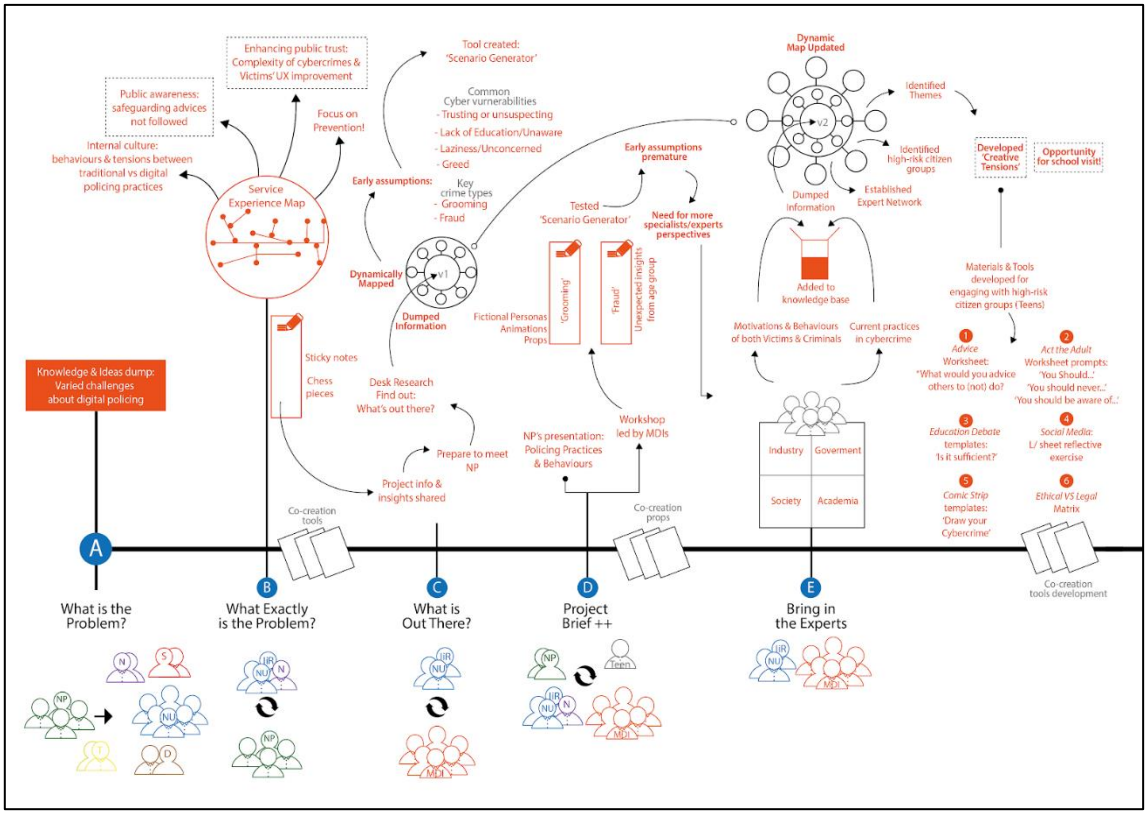


Figure 3: Part 1. A timeline of the project's innovation journey, illustrating the key design-led activities undertaken to date.

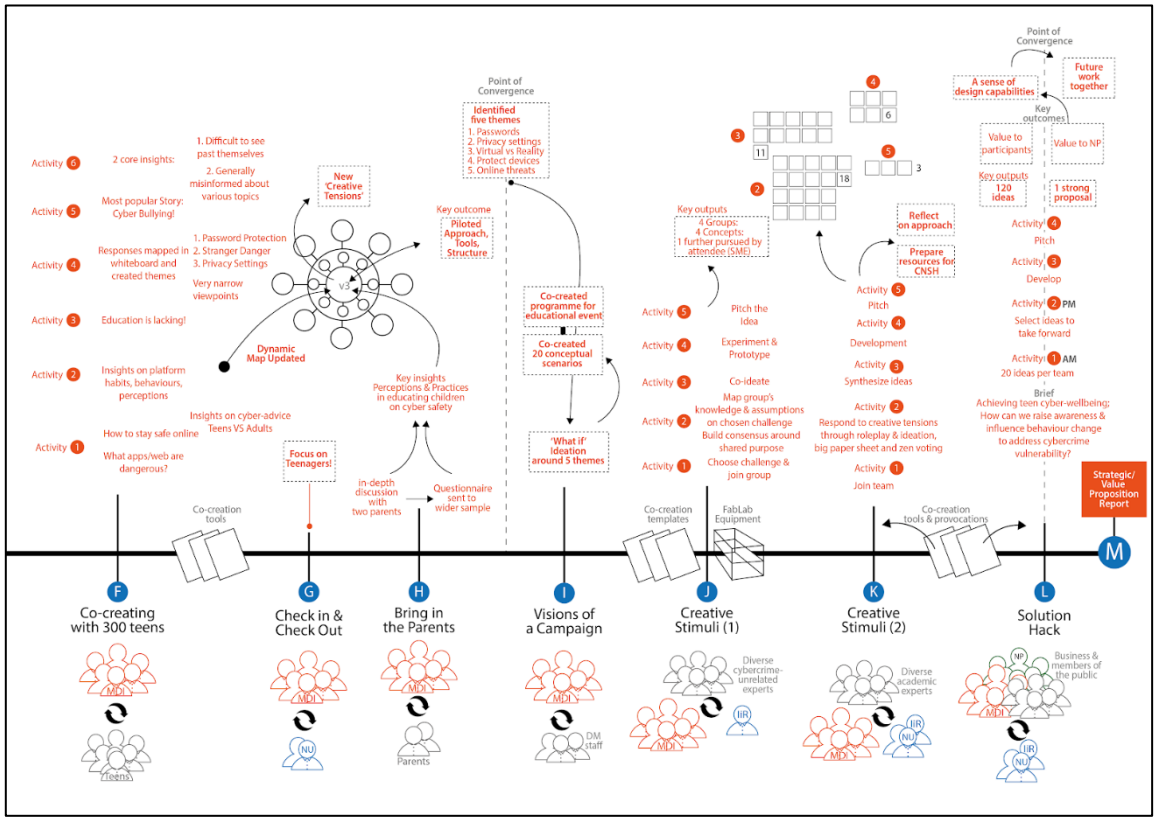


Figure 4: Part 2. A timeline of the project's innovation journey, illustrating the key design-led activities undertaken to date.

5.1. Project Activities

5.1.1. A: What's the problem*?*

In order to promote 'creative fusion', CFNE established regular regional networking events under the banner of 'CAKE' - Collaboration And Knowledge Exchange. These semi-informal sessions brought together a diverse community of academics and businesses. At one such event, a representative of Northumbria Police attended out of curiosity and hoping to discover how working with local digital and creative businesses might lead to development of digital applications to assist in addressing the challenges posed by cyber-crime. This combination of curiosity and need represented fertile ground for a trusting relationship to be established.

During facilitated preliminary discussions with Northumbria Police and the 5 CFNE University partners, police representatives highlighted areas of cybercrime policing that they saw to be key concerns. These included cyber-crime prevention, engaging with local software developers, technology horizon-scanning, to issues with investigation, such as improving internal communications within the police. Important at this stage in discussions was an honest admission from the CFNE University partners that they had no idea where the project would go, what the end results might be, nor a great deal of detail about how the project might progress. However, NU's team were confident that they would be able to establish some new ways of thinking and working that would reveal new knowledge for Northumbria Police. A number of discussions were required to establish trust and secure the project. The X team proposed to change the focus of the project to 'behaviour-change' and to consider ways to tackle unsafe digital practices (e.g. leaving Bluetooth on, not applying privacy settings or installing updates). The project goal was to co-create design proposals with CDIT businesses, students, academics and Northumbria Police staff which could then be developed further in the future.

5.1.2. B: What exactly is the problem?

This 2-hour session aimed to find out more about the challenge as perceived by the problem-owners. The team's key objective was to foster mutual understanding around the challenges. This was done through questioning and exploring the context in which the problem exists, relevant stakeholders, and any established assumptions.

Northumbria Police were not familiar with the creative nature of the session and therefore the space was curated in order to make it interactive and engaging. For example, the team strategically removed all seating from the room with the aim that attendees would spend their time 'doing'. Desks were dressed with large sheets of paper and various co-creation resources such as multi-coloured marker pens, sticky-notes, and chess pieces (to indicate hierarchy). Tea, coffee and chocolate fuelled the creative thinking.

In order to better understand the problem space, generative participatory techniques were used to facilitate conversations, capture insights and enable participants' discourse and reflection. Storytelling is a valuable tool in design-led innovation (Parkinson, et al. 2012) as it is in policing and investigation - taking and analysing a witness statement is familiar for police personnel. This awareness was used to design co-creative activities that facilitated story-making as a means of uncovering knowledge. The structure was intentionally open and the police were asked to identify a pertinent cybercrime scenario and describe how the event unfolded. Using a derivation of a service mapping exercise, participants co-created a

process/experience map that visually articulated the issues and challenges of digital policing in this scenario, answering why, how and what was going on (Figure 5).

Figure 5: A snapshot of co-creation activity during a creative problem definition session with the problem-owners.

It became apparent that cybercrimes can be perpetrated from anywhere in the world and are, therefore, difficult to solve. This resulted in Northumbria Police's focus being on prevention to explore how best to educate the public about how to better protect themselves online. Whilst, with hindsight, this might seem like an obvious observation, it is essential to the establishment of trust and buy-in that participants are able to see that they are instrumental in arriving at insights and developing solutions. Northumbria Police felt that their previous efforts in educating the public had been largely unsuccessful and therefore it was clear that innovative approaches were required. The 'swamp of data' (Spencer et al., 2017) that resulted from the mapping exercise was filtered into actionable issues which revealed three interconnected 'cybercrime' challenges:

1. Raising public awareness about cybersecurity: Northumbria Police has found that citizens and businesses do not follow data safeguarding advice resulting in avoidable cybercrime.
2. Enhancing trust between the public and the police: This could be done by improving public understanding of digital policing practices and processes, e.g. by communicating the complexity of cybercrime and improving victim's experiences during cases.
3. Internal culture: Different practices and attitudes within traditional and digital policing create tensions that result in slow responses to cybercrimes.

After the first creative problem-framing session, the team proposed an initial project plan entitled 'Cybercrime: Public Awareness and Behaviour-change'. The project aimed to develop early-stage concepts or solution opportunities using preparatory design work and a series of co-creation problem-framing and definition sessions involving diverse stakeholders. Solution opportunities would then be developed into working prototypes by CDIT businesses. To support this preparatory work, the team engaged six postgraduate students of

Multidisciplinary Innovation (MDI)[2] (Bailey and Smith, 2010), as catalytic agents for new thinking.

5.1.3. C: What's out there?

After being briefed on the project the students were asked to familiarize themselves with the problem-space. In order to document and reflect upon their secondary research the students used a variation of a dynamic stakeholder mapping tool (Knowles & Spencer, 2016). This stage resulted in initial evidence regarding common cyber-vulnerabilities (e.g. 'trusting or unsuspecting', 'uneducated or unaware', 'lazy or unconcerned') and two key cybercrime types, grooming and fraud. Based upon these insights, the students produced a 'scenario generator', a tool that included a set of creative props representing social media platforms, users and behaviours. This tool would be used during the briefing session with Northumbria Police to help them generate cyber-crime scenarios for further exploration. It is important that resources created for use in such workshops are both carefully designed, well executed and confidently deployed. In this respect they represent a manifestation of the dual role of designers as design executioners and multidisciplinary facilitators. Equally, they have to provide a degree of flexibility to adapt to changing circumstances in real-time.

5.1.4. D: Brief++

The team and the students hosted a 2-hour session attended by Northumbria Police representatives, student participants, and X academics. During the first 30 minutes, the police outlined key cybersecurity issues and behaviours. This was followed by a creative workshop run by students using their 'scenario generator'. Attendees were divided into two teams with each including a police representative. The physical space had been prepared with long paper sheets, sticky-notes, multi-coloured pens, and the 'scenario generator' props (Figure 6). The session was semi-structured in that there were some guided activities. Two short videos created by students introduced grooming and fraud. Key to this session was that the students had the creative confidence to expose incomplete knowledge and ideas to police experts and academics in a highly engaging and playful manner. This helped the students to understand, early on, that their assumptions about the problem-space were incomplete, simultaneously eliciting new knowledge from the experts. This is important, as revealing incomplete and fragile ideas is critically important to uncovering new knowledge and stimulating truly new ideas, but it is also challenging, requiring high-levels of creative confidence on behalf of the 'revealer'. Well-crafted tools and techniques that support that revelation add scaffolding that support the individual in this practice.

[2] Multidisciplinary Innovation students are, hereafter, referred to as 'the students' whilst other students engaged in the project as participants are referred to as 'student participants'.

Figure 6: Example of the co-creation props used in the 'Scenario Generator' tool during the Brief++ activity.

5.1.5. E: Bring in the experts

The students conducted 24 one-to-one interviews and sent questionnaires to experts from industry, government and academia during their 12-week project. Analysis revealed significant insights into the behaviours and motivations associated with victims and criminals. Moreover, the students identified existing cybersecurity initiatives. Key points from each interview were dynamically mapped (Figure 7) and used to update earlier versions of the map created during activity ‘C’. More critically, through data analysis, students identified groups that were at high-risk of becoming cybercrime victims (teenagers and older people) and key players in cyber-education (teachers and parents). Additionally, it was noted that different types of cybercrime effect different demographics. The complexity and diversity of cybercrimes means they cannot be tackled by just one solution. Sufficiency of relevant education practices was questionable and advice around actions to cybercrime prevention was unclear. The conflicting nature of the attitudes and behaviours collected from experts with different backgrounds were themed and labelled as ‘creative tensions’ (Sterling et al., 2018).

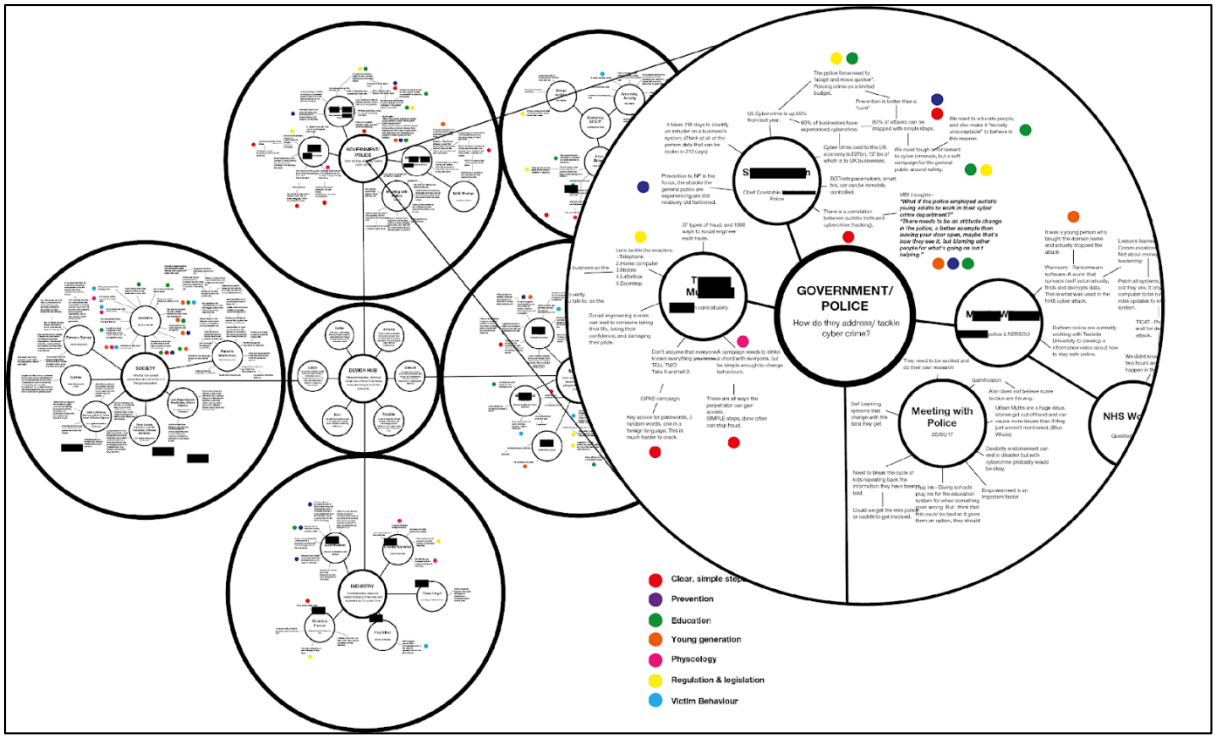


Figure 7: Example of the dynamic stakeholder map created by students to visualize the evolving network of experts engaged during the project.

5.1.6. F: Co-creating with 300 teens

The students created an opportunity to lead a workshop with young people, one of the identified high-risk citizen groups. They designed and developed six activities aimed at gaining a deeper understanding of the young people's experiences of interacting with digital devices. These activities encouraged participants to adopt different roles including advising others on cyber-security ('advice worksheets'), forming positions as if they were an adult ('act the adult' activity), evaluating current educational practices ('education debate'), reflecting on their use of social media ('social media' activity), exploring what is ethical and legal ('ethical vs legal' activity) and drawing scenarios to describe perceived cybercrimes ('comic strip' activity) (Figure 8).

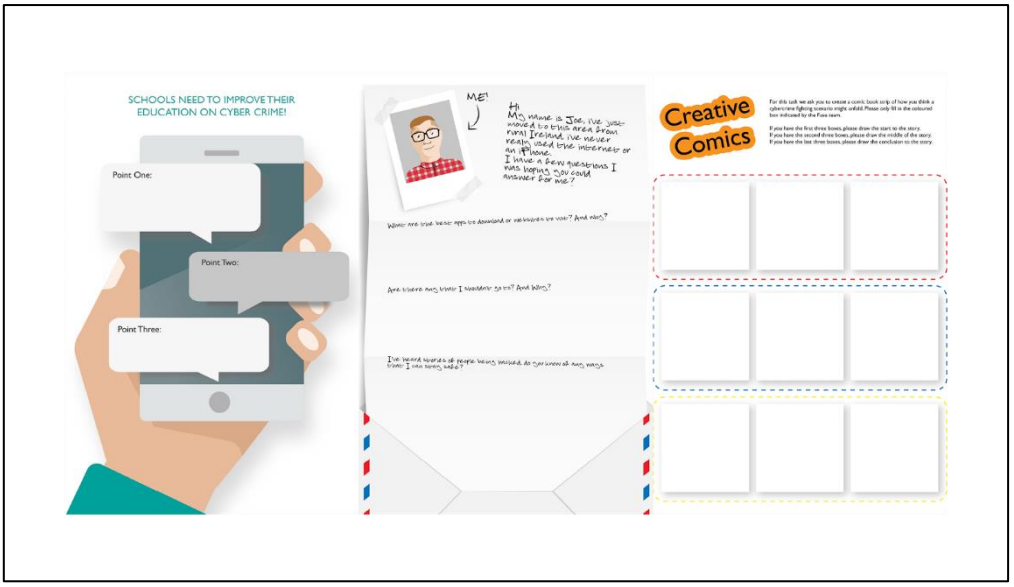


Figure 8: Examples of creative materials designed to engage teenagers in several co-creation activities around behaviours and attitudes in cybercrime.

The students engaged with around 300 teenagers during the day and generated significant insights into the attitudes and behaviours of young people, and the challenges surrounding cyber-education. Findings regarding teenager's use of social media and digital platforms included: their 'overdependence' on them as a result of peer-pressure and fear of missing out; the ways that friendship fallouts or bullying can be amplified through them; and criminal or hurtful behaviour not being perceived as 'real' when enacted over the internet. Significantly, the findings pointed to a shared consensus amongst teenagers and the various experts previously interviewed that cybercrime education in schools is not sufficient. This is focused, predominantly, on 'traditional' grooming, 'stranger-danger' and sharing of indecent images, and very little about much else, such as cyber-bullying, grooming through online games, password protection, privacy settings, and ID theft.

5.1.7. G: Check in and check out

The students met with the team at the midpoint of their 12-week project to reflect on their findings and create a future direction. This was the most significant point of convergence within the student-led project. Findings about young people seemed to stand out as both the most prolific and raised the most powerful challenges. The team chose to focus on young people as a demographic where raising awareness and changing behaviours could have the greatest long-term impact. Northumbria Police recognized that this was a sensible strategy that represented potential to realize greatest net benefit. The team and the students also decided to consider early stage ideas and opportunities to address the challenges associated with that age group. This meeting acted as a catalyst for the remainder of the project as it brought clarity and an impactful direction.

5.1.8. H: Bring in the parents

Having decided to focus on teenagers, the students sought to gain further insights from the perspective of parents. They organized a workshop to investigate how parents educate their

children around cyber-safety. Although low attendance at the workshop affected the breadth of perspectives, it resulted in detailed questioning and data acquisition. Findings suggested that parents differ regarding the level of online independence and safeguarding advice they give their children. In order to gain a wider perspective, students used insights from the workshop to compile an online questionnaire that was then sent out to parents and guardians. Analysis of the 20 responses revealed parents found it difficult to discuss cybercrime with their children and there was an expectation that children's cyber education should be a shared responsibility between parents, schools, government and industry. Findings from the parent-focused research activities and the school workshop were dynamically mapped and themed to reveal new 'creative tensions'.

5.1.9. I: Visions of a public cyber-wellbeing campaign

The rich insights gathered from the school and parent workshops really inspired the team. An early idea that developed from this inspiration was about targeting different demographics through creative events in venues across the region in order to interact directly with the public and provide cyber education in a fun way. An opportunity was established to engage with a regional museum to explore how they could become a pioneer in teaching this dynamic topic to children. The students ran a co-creation workshop with key museum staff which initially sought to create a 'shared understanding' of both the project's context and the museum's purpose. It was found that, whilst the museum has an excellent permanent collection and has run many family-oriented programmes, there remained clear opportunity to engage with digital innovation. The students then introduced five themes that their research suggested an educational plan ought to cover: passwords; privacy settings; virtual versus reality; protect devices; and online threats. Ideation around these themes focused on the possibilities that a new educational programme could provide. A number of fun and engaging activities were identified focusing on helping young people learn through play. After the workshop, the students further developed the ideas and created a set of 20 activity recommendations that the museum could implement as school sessions, family events, or permanent fixtures around the venue.

5.1.10. J and K: Towards an Open Innovation event: Developing and trialling creative stimulus material and provocations

The purpose of the preparatory design activities previously mentioned was to help the team form positions (briefs) and stimulus material in order to co-create early stage proposals and solution opportunities with CDIT businesses. An open innovation event entitled 'Solution Hack' was planned, for which the students needed to translate the breadth of knowledge generated through the preparatory work into provocations again using 'creative tensions'. To test the running of this event and explore how the creative stimuli would fuel it, a process of trialling and refining took place at two pilot events (Figure 9).

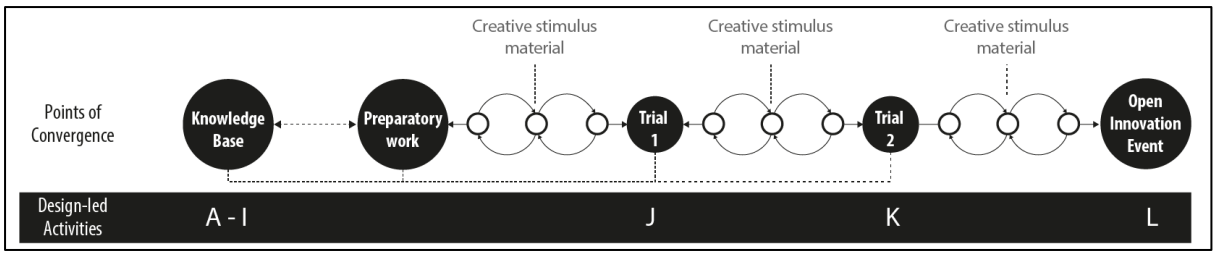


Figure 9: Through a semi-structured approach, the team undertook several divergent and convergent activities, translating new knowledge and insights into new creative stimulus material used and trialled at different co-creation events. Procedural and thematic knowledge gained at each event informed the next iterations.

Firstly, the team co-facilitated a 12-hour workshop (Trial 1), which involved disciplinarily diverse academics, businesses and experts, in intense ideation and development of physical prototypes/solutions using a partner organisation's 'FabLab' space which included 3D printers and other machinery. The students devised four provocative briefs around digital behaviours and also acted as creative facilitators during the event. Members of the team and the students facilitated the workshop and produced a series of actions to work through along with several design-led tools. These resulted in each of the four groups creating 'provotypes' (Boel & Dorovan, 2012); provocative concepts and prototypes.

The procedural and thematic knowledge gained from the 'Trial 1' event informed the design of a second pilot co-creation event, called here, 'Trial 2'. This day-long event was essentially the culmination of the student's work over the past two months and its fundamental purpose was to apply their findings and pilot their ideas and tools for the 'Solution Hack' event. It was also a chance to create and develop some initial solution opportunities relating to the problem. 17 participants drawn from the network of experts the students established in earlier phases of the project, attended the day which resulted in 18 idea cards, synthesized to 11 for further development from which 6 were further refined and 3 taken to the final presentation stage. A number of observations in relation to the participants' behaviours during the event (e.g. a tendency of choosing the easiest to make ideas when it comes to development and pitching) and in the day's structure (e.g. the impact long breaks had on momentum and the importance of making clear when different sessions start and finish) were recorded and many of the initial recommendations in the design of the forthcoming 'Solution Hack' event were altered as a result.

5.1.11. L: Solution Hack

In a creative planning event the team finalized the design of the Solution Hack's agenda and created the 6 briefs, aligning and enhancing the creative tensions. They introduced the notion of Attitude-Behaviour-Vulnerability as central to the event's choreography.

The purpose of the Solution Hack event was to engage CDIT SMEs and Northumbria Police to generate actionable solutions proposals to address some of the challenges posed by poor cybersecurity amongst teenagers. To achieve this, the team used expertise in inclusive design-led innovation approaches to encourage the sharing of knowledge, skills, experience, expertise and opinions and combine these to create new ideas or build on existing ones.

The 12-hour open innovation event brought together 30 participants from business, Northumbria Police, student participants and members of the public. It used the creative tensions previously designed to highlight conflicting perspectives about particular teen attitudes, behaviours and cyber-vulnerability. These, and a package of supporting materials (Figure 10), formed the brief: *Achieving teen cyber-wellbeing; How can we raise awareness*

and influence behaviour-change to address cybercrime vulnerability? This approach, along with the use of bespoke resources, is critically important in providing participants with key insights drawn from extensive research as the distillation of what is important for the creative session that follows.

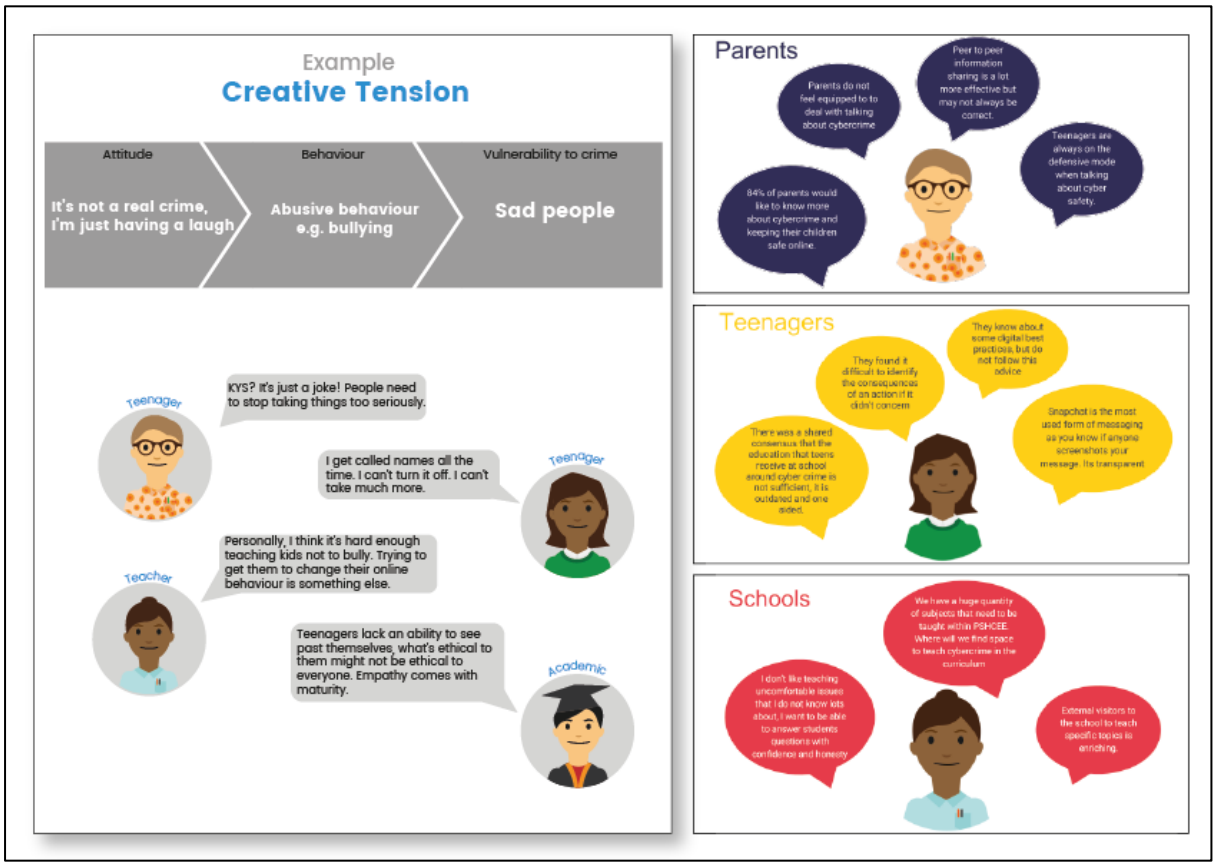


Figure 10: Examples of stimulus materials drawn from the team's research findings, provided to teams to describe the context and drive creative thinking amongst participants.

In the morning, five teams from mixed backgrounds worked together to generate 80 ideas in response to their briefs. For the afternoon session attendees formed two teams; each individual from each team selected those ideas that they felt had potential for development. Prompted by sets of challenges (Figure 11) that aimed to guide the development of ideas, and informed by feedback from police representatives, each team constructed and pitched a solution proposal. One of the proposals presented a concept for an integrated cyber-education programme that saw students acting as cyber-ambassadors, seeking to promote 'authentic' peer learning delivered by students, rather than the teachers. The second proposal was a framework for exploring digital ethics, through actions and consequences. The framework, aligned to primary school age groups, built a portfolio of exciting and engaging activities allowing young people, their peers, teachers, family and carers to blend digital and physical interactions, communications and encounters to try to understand the very real ethical and potentially dangerous consequences of certain digital behaviours.

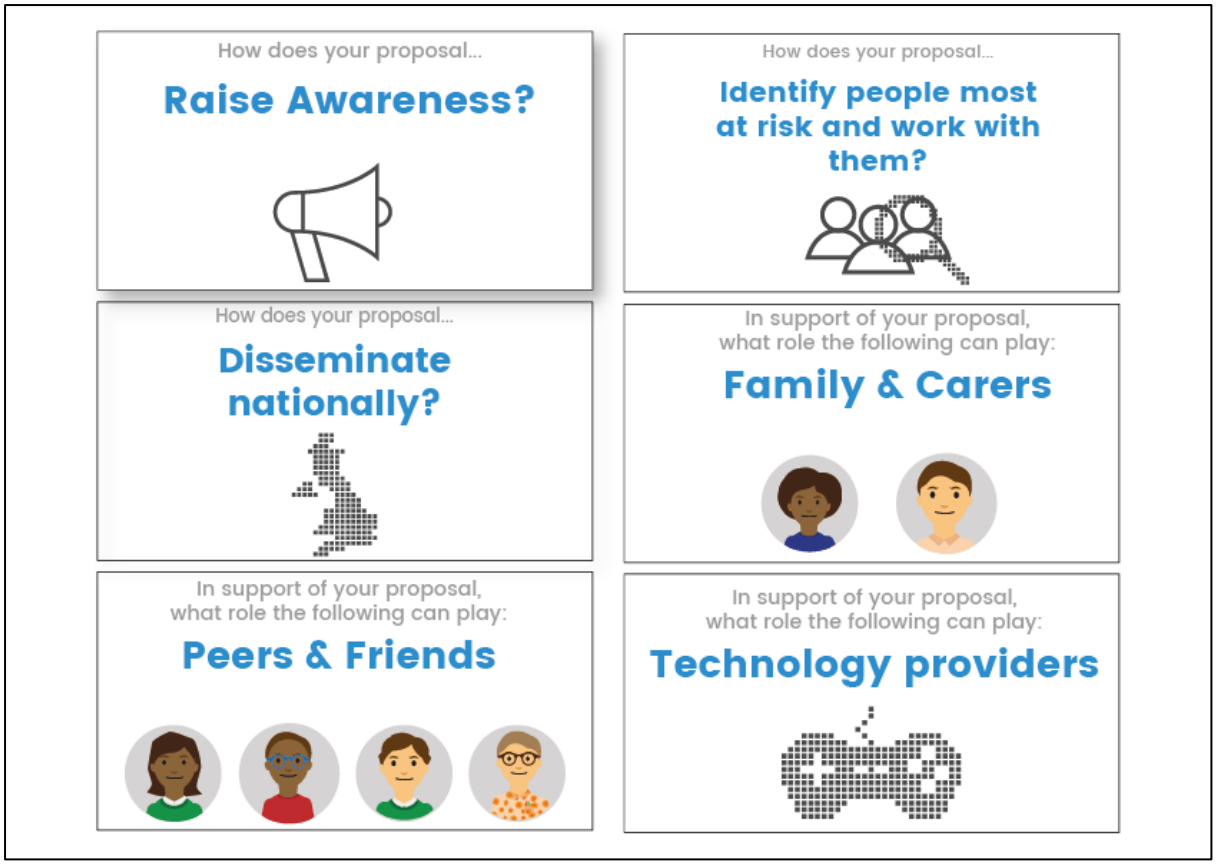


Figure 11: Design challenge cards presented to each team during ideas development to inspire a multidimensional approach.

The event created value to both attendees and police representatives; the former gained from being exposed to a pressing social challenge; experiencing a novel approach to problem solving; and by working with a range of new people from different professional and social backgrounds with different levels of experience and expertise. Northumbria Police reported that the event allowed them to work with a University in a new way, through an approach that generated ideas for future initiatives and actions;

> *Working creatively, with a range of experts, to generate solutions was tremendously exciting. If we can execute and deliver some of these ideas, they will catch on like wildfire, there is such potential to make a difference* (Senior Northumbria Police member).

5.1.12. M: Strategic position

During activity M, the team carried out a number of creative sessions and revisited research and design outputs produced throughout the 12 project phases. The aim was to analyse and synthesize the rich collateral into a set of key value propositions and formulate a 'strategic report' to share with Northumbria Police and continue to work with them to seek funding to see proposals emerging from the event through to pilot implementation.

The strategic report outlined key findings and recommendations on how Northumbria Police could take a leadership position in cybercrime prevention both regionally and nationally. For example, one of the key project findings was that 'cyber-education' resources need to be

more relevant, detailed and draw on real cases in order to engage young people. The team suggested that by adopting an original, creative approach, Northumbria Police could create resources which are both informative and truly engage young people in discussion and debate around the difficult decisions they have to make during internet use. The report further proposed a strategic approach to achieve this; by connecting with local creative and digital businesses to, a) create rich, youth-focused compelling case studies, b) generate assets to communicate these narratives effectively from multiple perspectives (perpetrator, victim, peers, parent, witness, investigating officer etc.), c) create platforms which support young people to engage in discussion, debate and community action and help adults to facilitate this engagement, d) offer the police tools for staff development (Figure 12).

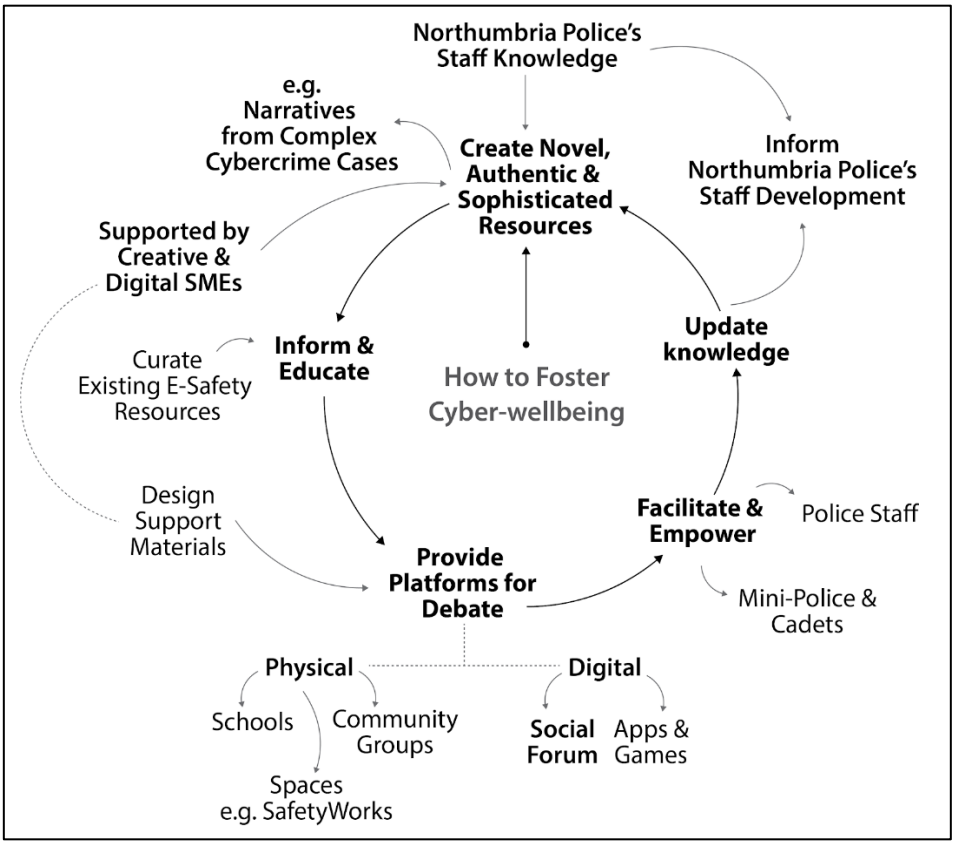


Figure 12: Northumbria University's strategic proposal for a program of initiatives to enable Northumbria Police to take a leadership position in cyber-crime prevention.

6. Design-led enablers throughout project activities

Over the 13 project activities, the team arrived at three key convergent points, a) framing problem spaces and themes (activities A-H), b) early stage actionable solution opportunities that were used both for stimulating creative thinking and as strategies for developing solutions (activities I-L), c) development of a strategy to foster cyber-wellbeing (M).

Figure 13 depicts the range of enablers employed throughout the different phases of the projects and their points of convergence.

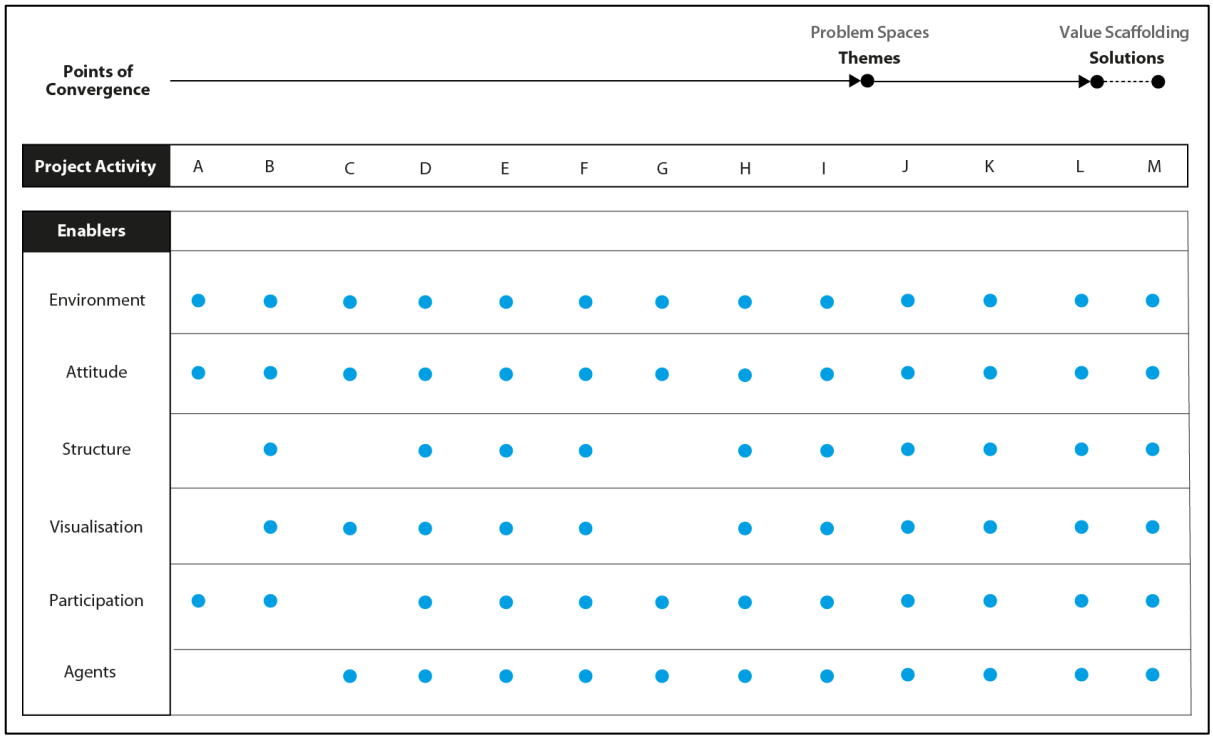


Figure 13: The different design-led enablers employed during the 13 project phases based on the conceptual framework introduced earlier in the paper.

While it can be seen as though almost all enablers were present across the majority of the project activities, upon closer investigation, the intensity with which the enablers influenced each phase outcomes (hence, the project itself) varied.

For example, in activity D ('Brief++'), the 'participation' enabler was deficient; only a few police representatives attended the session due to a security incident demanding their attention. This had an impact on the 'structure' enabler as the planned creative activities were devised with more expert participants in mind. Moreover, this deficiency affected the project by slowing down one important early stage objective: establishing and engaging expertise in the process.

During activity E ('Bring in the Experts') the students engaged with experts across industry, society, government, and academia, all of whom contributed knowledge. However, only some converted into activists (in that they actively participated in co-creation activity), thereby missing the opportunity of deeper engagement in subsequent events. Enablers such as being open to a changing 'structure' meant that students were able to identify that collecting teacher's perspectives would be beneficial and adapt their plans to include one-to-one interviews with teachers. In the same way, the flexibility of the 'structure' enabler allowed students to compensate for the deficit of parents during Activity H ('Bring in the parents') by a) by collecting more in-depth data and b) devising other means to enable more diverse data-collection.

In activity J 'Trial 1' the team had little to no control over the environment and participants as the partner institution managed these. However, as the event took place at a 'FabLab', this helped foster a mindset of 'making' and 'experimentation'. To compensate for a lack of control, enablers such as 'structure' ranging from the creation of briefs prior to the event, to the role the team and students had in facilitating the day were important, while the

‘visualisation’ and ‘attitude’ enablers provided a set of fun and engaging activities. While ‘participation’ was high in that all teams actively engaged and co-created according to their challenges, the enabler can be seen as deficit as only one team explored challenges relating to cyber-wellbeing which resulted in only one relevant concept coming out from that activity.

Deficits were also observed in enablers ‘structure’, ‘visualisation’, and ‘participation’ during activity K ‘Trial 2’. For example, momentum was negatively impacted due to the lack of a well-planned ‘structure’ in the day and the unclear start/finish points during different activities. This highlights the importance of balancing structure and flexibility. Moreover, participants were not obliged to stay for the whole day which caused disruption to the composition of teams and no proactive mechanisms were in place to anticipate this. On the other hand, the ‘visualisation’ enabler consisted of such a wealth of tools and creative stimuli that it was questionable whether they fostered a better engagement or overwhelmed and disrupted participants’ creative thinking. The lack of police expertise and lower engagement from academics of partner institutions (partly because of not turning enough ‘experts’ into ‘activists’) had a detrimental effect on the day’s outcomes.

During activity L (‘Solution Hack’) the team identified two enabler deficits, ‘visualisation’ and ‘participation’. In the former enabler, it was observed that some participants treated creative materials (provocations and tensions) as ‘descriptions of cybercrime’ rather than ‘context for action’, thereby dismissing them in order to pursue solutions based on their personal experience (rather than the supplied research). In terms of the ‘participation’ enabler, this event fell short of achieving engagement with the CDIT businesses. However, in contrast to activity K discussed earlier, the flexible ‘structure’ had anticipated the disruption caused when participants stayed only for part of the day and successfully enabled a non-disrupted event.

Finally, during activity M, all enablers were evident during the team’s review of creative outputs but ‘environment’, ‘attitude’, and ‘participation’ were particularly useful. For instance, the team was able to utilize a dedicated project space to gather and visualize relevant project outputs and stimulate the team’s creative thinking. Prior to the formulation of the final strategic report, the team hosted Northumbria Police representatives in this space in order to showcase research and creative outputs and to discuss their strategic position and recommendations that formed the basis of the final report.

Figure 14 depicts the varying influence of the enablers during the different project phases.

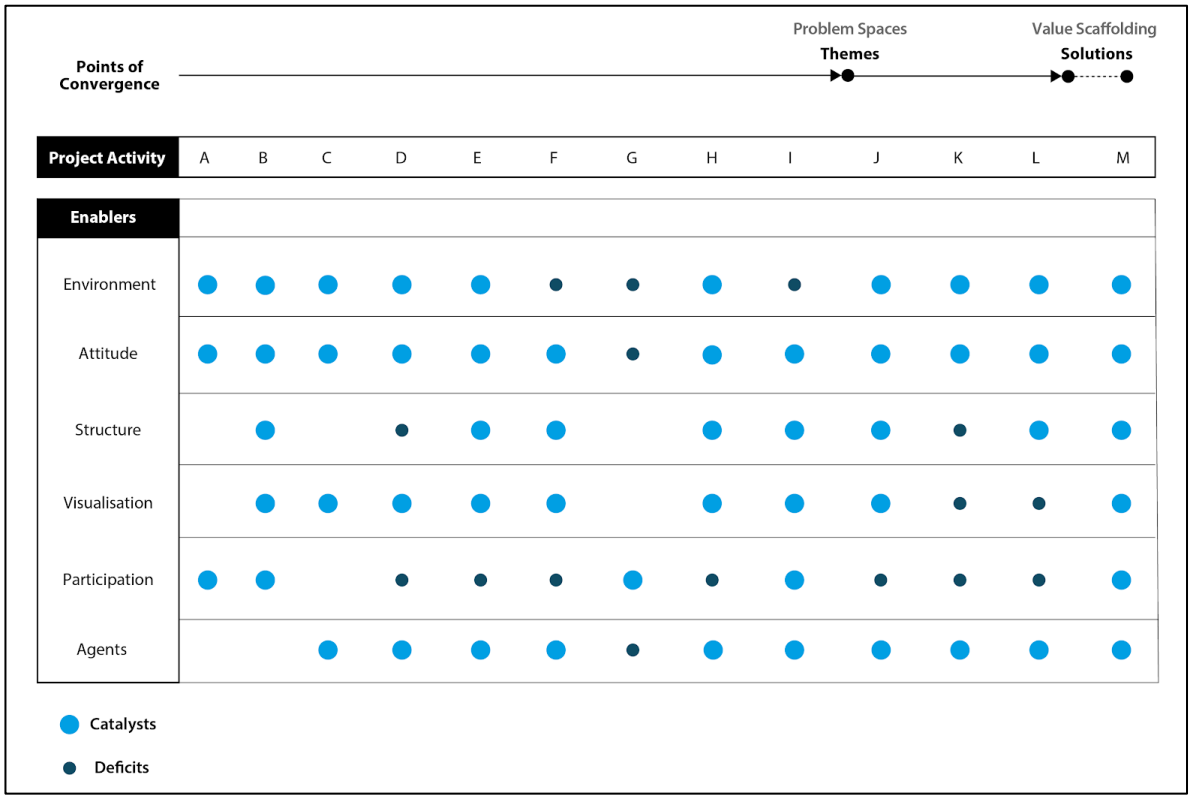


Figure 14: An illustration of how different enablers influenced project outcomes during the different activities. Larger diameter circles indicate greater density and importance, while the smaller indicate a deficit.

7. Lessons Learned

On Design Frames

Past research has argued that in dynamic wicked problems, there is a need to be able to question critically and break down what is truly important to which stakeholders. Indeed, adopting an approach that seeks to tease out actionable design-briefs as part of a larger, semi-structured programme allows organisations to consider where to focus energy and resource. The case study described in this article found that by acknowledging the co-evolution of problem and solution-spaces as part of *trust-building* at the start of a programme of work, it is possible to enter into that work uncertain about the specific methods, tools or destination, but aware that, if required, there will be stepping-off points at the project's points of convergence. Moreover, the case study identified an area of equal importance (yet generally neglected in current design-led studies), that is, the language used to describe and draw actors together around a 'wicked problem'. By adopting new, positivist language, shifting from 'problem' and 'solution' to 'situation' and 'opportunity', we can shift to a more optimistic and creatively confident mindset amongst 'situation'-owners.

The case study discussed in this article described NU's design-led approach to tackling a dynamic wicked situation: cybercrime. Through this approach, academics, researchers and postgraduate students engaged stakeholders creatively to explore young people's cyber-vulnerability and define the tools needed to help raise awareness and influence positive behaviour-change. As understanding of the situation and opportunities co-evolved throughout this collaboration, it revealed a different reality from that which Northumbria Police had

originally thought was needed to help 'solve the problem'. To reach solution opportunities, NU's approach (re)framed and transformed the wicked problem into a *design situation* by collecting knowledge, asking pertinent questions, and generating speculative ideas. Such problem-transformation can be found in the way the situation was eventually framed: from 'cybercrime' to 'cyber-wellbeing' and from 'prevention' to 'raising awareness and influencing behaviour-change to address cybercrime vulnerability'. Furthermore, Northumbria Police had originally approached CFNE with a *problem to solve* i.e. how to prevent cybercrime. At the time, it was thought that the solution could be simply developing a number of 'cool' digital applications to engage the public with 'what to do/not to do' information and guidance. Through a design-led approach, the problem was reframed as a *situation* which led to deeper understanding of what was actually needed while revealing new *opportunities* in the specific situation developed; a more holistic, contemporary and relevant 'cyber-education' program whose impact could be reaching two worlds simultaneously: new public engagement strategies and better curation of resources, would also result to contemporaneous knowledge readily available to support internal staff development.

Activities such as; engaging with diverse expertise across industry, academia, society, and government; identifying and engaging with high-risk citizen groups; trialling creative materials in pilot co-creation events; and a series of creative planning events, were amongst the most valuable in situation-framing. This framing was achieved through a process that needed careful facilitation to bring people together around a common purpose and foster their creativity.

On Co-creation Enablers

This study proposes 6 enablers (environment, attitude, structure, visualisation, participation, and agents) that were deployed to bring stakeholders together to move from a position of ambiguity to one where there are strategic and actionable solution opportunities. The evidence presented in this paper suggests that amongst the 6 enablers, the 'participation' enabler is the hardest one to activate. It is particularly challenging when stakeholders are not familiar with design-led approaches, not supported by their organisational culture or there are no immediate (monetary) rewards in the case of commercial businesses. NU's design-led strategy to tackle 'participation' deficits in the case study in question was through another enabler, 'structure'; having a highly adaptable structure enabled the team to anticipate and reform in response to changing circumstances throughout the project, especially during stakeholder engagement events. However, this strategy fell short in regard to the team's lack of success in attracting engagement from commercial businesses such as the digital SMEs - even adapting the project structure to suit the needs of these businesses failed to achieve significant engagement as the businesses were unable to see an immediate return on time invested. This is a significant and critical lesson for anyone seeking to develop this sort of relationship.

Previous research has noted the important role of visualisation in creating common language, understanding and purpose amongst participants. However, the 'visualisation' enabler can encompass such a wealth of tools and creative stimuli that this can become overwhelming and disruptive to participation. In this study it was questionable, on occasion, whether visualisation tools fostered a better engagement or disrupted participants' creative thinking. Novice facilitators, such as the students involved in this case study, demonstrated a tendency to over-resource workshops; apprehensive about achieving enough creative engagement from

participants, they would overload them with visual prompts, templates and tools, thereby generating too much 'noise' to leave space for creativity.

Finally, it was observed that the 'agents' enabler, represented in this project by a group of multidisciplinary students, through their own contextual naivety, gave participants permission to behave creatively and ask apparently naive 'what if' and 'why' questions which are critical to creative practice. This had an amplifying effect upon every other enabler, making them a crucial ingredient in NU's design-led approach to business-engaged co-creative research and innovation. The consequence of this, combined with the adoption of the optimistic situation/opportunity language, contributed to a perceptible increase in evident creative confidence amongst those who did convert from 'expert' to 'activist'.

8. Concluding remarks

It is clear from this case study that the co-creation enablers employed do support stakeholders in developing the creative confidence required to transition from 'expert participant' to co-creation activist, and the authors have concentrated their evaluation on the lessons that can be learned when the enablers are not as effective as hoped. Similarly, the case study demonstrates how design-led approaches can translate a wicked problem into actionable innovation briefs. For practitioners wishing to adopt such approaches, the study highlights the critical importance of employing an adaptable, fluid approach when addressing wicked problems. This requires a high degree of confidence and experience on the part of the facilitators and trust from all stakeholders. Furthermore, striking the right balance with the number and nature of supporting resources used in facilitation is important and poses the further question 'when do enablers become disablers and how can practitioners guard against this?' Within academia, we have the opportunity, particularly where an Integrated Academic Practice model (Bailey and Smith, 2016) is employed, to prototype, test and refine such tools within the context of integrated research and education projects conducted with external partner organisations. In this way, academics are able to support the development of knowledge and practice in co-creative practice.

Acknowledgements

A shorter form of this research was originally published in:

Bailey, M., Spencer, N., Chatzakis, E., Lampitt Adey, K., Sterling, N., Smith, N., 2018. *"From wicked problem to design problem: Developing actionable briefs and solution opportunities through a collaborative, multidisciplinary design-led approach"*. In: Design Research Society (DRS) 2018, *Design as a catalyst for change*. Limerick, Ireland, 25-28 June 2018.

We wish to thank all participants and actors involved throughout our project for giving off their time and expertise, especially the members from Northumbria Police and our Multidisciplinary Innovation students.

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